SIEMENS

MC35 Terminal

Siemens Cellular Engine

Hardware Interface Description

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Wireless Modules

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0 Version history

This chapter reports modifications and improvements over previous versions of the document.

Preceding document: "MC35T Hardware Interface Description" Version **01.01**
New document: "MC35T Hardware Interface Description" Version **03.02**

Chapter	Page	What is new
1.2	7ff	GPRS multislot class 8, coding schemes 2 and 4 added PBCCH support added GPRS data rates updated, Table 2: Coding schemes and data rates added SMS storage now SIM card plus mobile equipment List of baudrates supported during autobauding mode added Firmware upgradable over serial interface or SIM interface Functions of status LED added
2.3	15	GPRS multislot class 8, coding schemes 2 and 4 added. New figures of the MC35 module's baseband and RF side added.
2.4	16	SLEEP mode: NON-CYCLIC and CYCLIC SLEEP modes supported
2.5.1	18f	Power Down mode described in greater detail (Note 2)
2.5.2	21f	Description of SLEEP modes added
2.5.3	23	Summary of wake-up events added
2.5.5.1	27	Table 8: Audio Modes. Voiceband characteristics revised
2.5.5.2	28	Recommendations for connecting handsfree devices or headsets
2.5.7	30	Firmware update over SIM interface now supported
2.5.8	30	New status LED function: Ability to indicate activated GPRS context and GPRS transfer
4	33ff	Table 17: AT adjustable parameters. Note added: inCalibrate, outCalibrate and sidetone internally truncated to 32767.
5	39	Brief overview of firmware upgrade solutions added.

1 Introduction

This document is a supplement to the "User Guide" supplied with your MC35 Terminal. The purpose of the document is to provide additional technical details on the hardware platform and the external interfaces of the MC35 Terminal.

The information are intended for users, developers or manufacturers who design and build cellular applications beyond the standard setup. The scope of this document includes interface specifications, electrical issues and mechanical characteristics of MC35T. It specifies standards pertaining to wireless applications and outlines requirements that must be adhered to for successful product design.

For basic information on MC35T, a feature overview, installing instructions and safety precautions please refer to the "User Guide".

1.1 References

[1] MC35 Hardware Interface Description, Version 03.02 (describes the MC35 cellular engine incorporated in MC35 Terminal, see also Chapter 2.3)
[2] TC35 Terminal / MC35 Terminal User Guide, Version 03.02
[3] AT Command Set for MC35 and MC35 Terminal, Version 03.02
[4] MC35 GPRS Startup User's Guide
[5] MC35 Remote-SAT User's Guide
[6] Application Note 16: Updating MC35 Firmware, as of Version 02.00
[7] DSB35 Support Box - Evaluation Kit for Siemens Cellular Engines
[8] MC35 Multiplexer User's Guide, as of Version 02.00
[9] Application Note 02: Audio Interface Design
[10] Application Note 14: Audio and Battery Parameter Download
[11] Multiplex Driver Developer’s Guide for Windows 2000 and Windows XP
[12] Multiplex Driver Installation Guide for Windows 2000 and Windows XP

Further information on Siemens cellular engines and a list of distributors can be found at http://www.siemens.de or http://www.siemens.com/wm.

1.2 Key features of MC35 Terminal

Table 1: Key features

Feature	Implementation
Transmission	Voice, data, SMS, fax
Power supply	Single supply voltage 8V to 30V
Frequency bands	Dual Band EGSM900 and GSM1800 (GSM Phase 2+)
PBCCH support	Support of Packet Switched Broadcast Control Channel allows to benefit from future GPRS broadcast services when offered by the network operators. No need for later hardware modifications.
GSM class	Small MS
Transmit power	Class 4 (2W) for EGSM900 Class 1 (1W) for GSM1800
GPRS connectivity	GPRS multi-slot class 8 GPRS mobile station class B Note referring to Class B: GPRS data transfer is suspended upon incoming or outgoing voice call and resumed when voice call hangs up. Concurrent GPRS data transfer and CSD / fax call are not supported.
SIM card reader	internal
External antenna	Connected via antenna FME connector
Ambient temperature range	-20°C to +55°C (normal operation) -40°C to +85°C (storage)
Current consumption @12V see Table 13	TALK mode (peak) 1,2A (pulsed 577ms at T=4,615ms) TALK mode GSM: 170mA (typical average) DATA mode GPRS: 180mA (typical average) IDLE mode: 35mA (typical) SLEEP mode: 30mA (typical) Power Down mode: 700µA (typical)
DATA *GPRS:*	GPRS data downlink transfer: max. 85.6 kbps (see Table 2) GPRS data uplink transfer: max. 21.4 kbps (see Table 2) Coding scheme: CS-1, CS-2, CS-3 and CS-4 MC35 T supports the two protocols PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) commonly used for PPP connections.
CSD:	CSD transmission rates: 2.4, 4.8, 9.6, 14.4 kbps, non-transparent Unstructured Supplementary Services Data (USSD) support

Feature	Implementation
Speech codec (triple rate codec)	Half Rate (ETS 06.20) Full Rate (ETS 06.10) Enhanced Full Rate (ETS 06.50 / 06.60 / 06.80)
SMS	MT, MO, CB, Text and PDU mode SMS storage: SIM card plus space for 25 SMS in the mobile equipment
FAX	Group 3 : Class 1, Class 2
Audio interface	Analog (microphone, earpiece)
Serial interface	RS-232 (CMOS level) bi-directional bus for commands / data using AT commands MC35T supports Multiplex mode according to the GSM 07.10 Multiplexer Protocol and enables one physical serial interface to be partitioned into three virtual channels. This allows you to take advantage of up to 3 simultaneous sessions between MS and TA. For example, you can transfer data over one channel while two further channels are free to control the Terminal with AT commands.
Selectable baud rate	300bps...115kbps (AT interface)
Autobauding range	Supported baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
Supported SIM card	3V
Phonebook management	Supported phonebook types: SM, FD, LD, MC, RC, ON, ME
SIM Application Toolkit	Supported
Status LED	Indicates operating states (e.g. network search or current log-in state, voice or data call, activated GPRS context, GPRS transfer, Power Down or Sleep mode)
Reset of MC35 Terminal	Reset via AT command or Power Down Signal
Firmware upgrade	Via RS232 or SIM interface
Real time clock	Implemented (clock frequency 32.768kHz)
Timer function	Programmable via AT command
Size	65x74x33 mm (approx.)
Weight	130g

Table 2: Coding schemes and data rates

Coding scheme	1 Timeslot	2 Timeslots	4 Timeslots
CS-1:	9.05 kbps	18.1 kbps	36.2 kbps
CS-2:	13.4 kbps	26.8 kbps	53.6 kbps
CS-3:	15.6 kbps	31.2 kbps	62.4 kbps
CS-4:	21.4 kbps	42.8 kbps	85.6 kbps

1.3 Standards

This product has been approved to comply with the following directives and standards.

Directives

99/05/EC	Directive of the European Parliament and of the council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity
89/336/EC	Directive on electromagnetic compatibility
73/23/EC	Directive on electrical equipment designed for use within certain voltage limits (Low Voltage Directive)
99/519/EC	Specific absorption rate (SAR) (recommendation)

Standards of type approval

ETS 300 607-1	Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformance specification; (equal GSM 11.10-1=>equal 3GPP51.010-1)
ETSI EN 301 511	V7.0.1 (2000-12) Candidate Harmonized European Standard (Telecommunications series) Global System for Mobile communications (GSM); Harmonized standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2of the R&TTE directive (1999/5/EC) (GSM 13.11 version 7.0.1 Release 1998)
ETSI EN 301 489-7	V1.1.1 (2000-09) Candidate Harmonized European Standard (Telecommunications series) Electro Magnetic Compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 7: Specific conditions for mobile and portable radio and ancillary equipment of digital cellular radio telecommunications systems (GSM and DCS)
EN 60 950	Safety of information technology equipment
ES 59005/ANSI C95.1	Considerations for evaluation of human exposure to Electromagnetic Fields (EMFs) from Mobile Telecommunication Equipment (MTE)in the frequency range 30MHz-6GHz (relevant for applications)

Requirements of quality

IEC 60068	Environmental testing
DIN EN 60529	IP - codes
DIN EN ISO 11469	Typical Plastic Parts

1.4 Terms and abbreviations

Table 3: Terms and abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AGC	Automatic Gain Control
ARP	Antenna Reference Point
ASIC	Application Specific Integrated Circuit
BTS	Base Transceiver Station
CB	Cell Broadcast
CODEC	Coder-Decoder
CPU	Central Processing Unit
DAI	Digital Analog Interface
dBm0	digital level, 3.14dBm0 corresponds to full scale, see ITU G.711, A-law
DCE	Data Communication Equipment (typically modems, e.g. Siemens GSM engines, such as MC35 and MC3r Terminal)
DSB	Development Support Box
DSP	Digital Signal Processor
DSR	Data Set Ready
DTE	Data Terminal Equipment (typically computer, terminal, printer or, for example, a GSM application)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
EGSM	Enhanced GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FDMA	Frequency Division Multiple Access
FR	Full rate
G.C.F.	GSM Conformity Forum
GPRS	General Packet Radio Service
GSM	Global Standard for Mobile Communication
HF	Hands-free
HR	Half rate
HW	Hardware
IC	Integrated Circuit

Abbreviation	Description
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identifier
I/O	Input/ Output
IGT	Ignition
ISO	International Standards Organization
ITU	International Telecommunications Union
kbps	kbits per second
Li-Ion	Lithium-Ion
LVD	Low voltage Directive
Mbps	Mbits per second
MCU	Microcomputer Unit
MMI	Machine Machine Interface
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
PA	Power Amplifier
PCB	Printed Circuit Board
PCS	Personal Communication System
PD	Power Down
PDU	Protocol Data Unit
PLL	Phase Locked Loop
R&TTE	Radio and Telecommunication Terminal Equipment
RAM	Random Access Memory
RF	Radio frequency
RI	Ring Indication
ROM	Read -Only Memory
Rx	Receive direction
SIM	Subscriber Identification Terminal
SMS	Short Message Service
SRAM	Static Random Access Memory
SW	Software
MC35	Short for MC35 GSM Engine
MC35T	Short for MC35 Terminal
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
Tx	Transmit direction

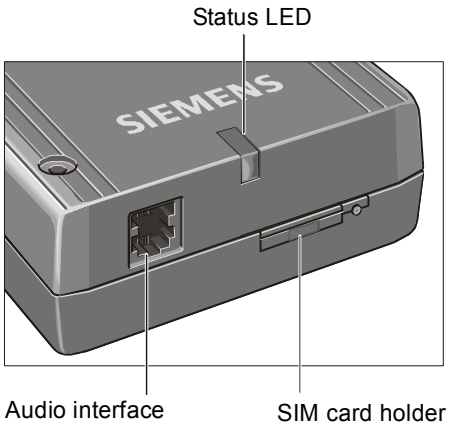
Abbreviation	Description
UART	Universal Asynchronous Receiver and Transmitter
VAD	Voice Activity Detection
ZIF	Zero Insertion Force
Phonebook abbreviations	
FD	SIM fixdialling phonebook
LD	SIM last dialling phonebook (list of numbers most recently dialled)
MC	Mobile Equipment list of unanswered MT calls (missed calls)
ME	Mobile Equipment phonebook
ON	Own numbers (MSISDNs) stored on SIM or ME
RC	Mobile Equipment list of received calls
SM	SIM phonebook

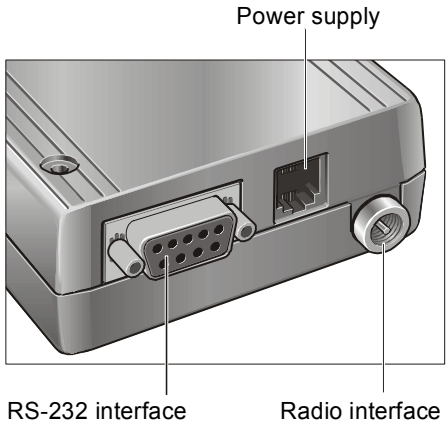
2 Interface description

2.1 Overview

MC35 Terminal provides the following connectors for power supply, interfacing and antenna:

- 6-pole Western plug (female) for power supply, ignition, power down signal
- 4-pole Western plug (female) for audio accessory, such as a handset
- 9-pole (female) SUB-D plug for RS-232 serial interface
- FME Jack (male) for antenna (Radio Interface)
- SIM card holder





2.2 Block diagram of a GSM/GPRS application

Figure 1 shows a block diagram of a sample configuration that incorporates a MC35 Terminal and typical accessories.

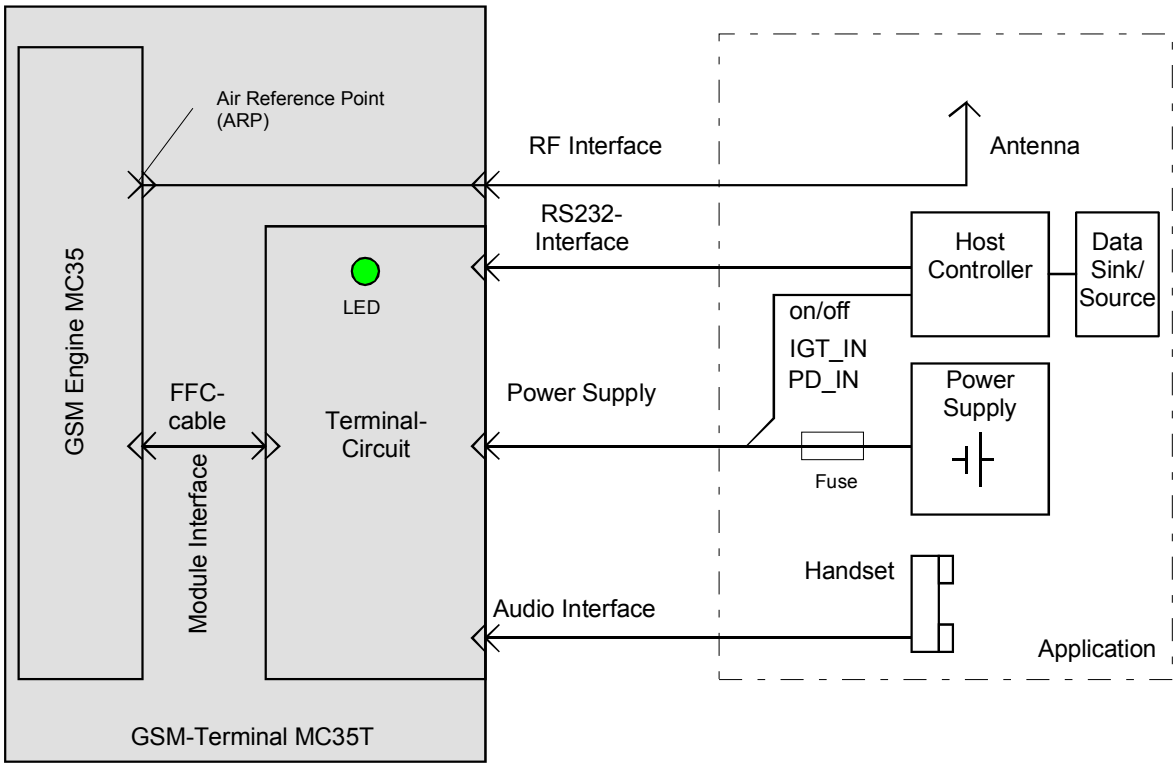


Figure 1: Block diagram of a MC35 Terminal application (example)

2.3 The MC35 GSM/GPRS Engine

The MC35 GSM/GPRS Engine is a major functional component of the MC35 Terminal that handles all the processing for audio, signal and data within a GSM/GPRS cellular device. Internal software runs the application interface and the whole GSM and GPRS protocol stack. A UART forms the interface to the Terminal Circuit.

MC35 is a product variant of the well-proven TC35T dual band GSM Terminal. It supports all the features of TC35T and, on top, offers the advantages of the fast GPRS technology. Designed to easily provide radio connection for voice and data transmission it integrates seamlessly with a wide range of GSM/GPRS application platforms and is ideally suited to design and set up innovative cellular solutions with minimum effort.

MC35T supports GPRS multislot class 8 (4 Rx, 1 Tx time slot) and GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. It operates in the frequency bands GSM 900 MHz and GSM 1800 MHz.

A GSM baseband processor contains all analog and digital functionality of a cellular radio. Designed to meet the increasing demands of the GSM/PCS/GPRS cellular subscriber market, it supports FR, HR and EFR speech and channel coding without the need for external hardware.

The RF part of the MC35 Engine is based on the SMARTi Transceiver Chip. The transceiver consists of a heterodyne receiver part, an upconversion modulation loop transmitter, a RF PLL and a fully integrated IF synthesizer.

The internal antenna cable connects to the connector type GSC from Murata with a 50Ω impedance. This GSC connector is the ARP (Air Reference Point) for type approval measurements.

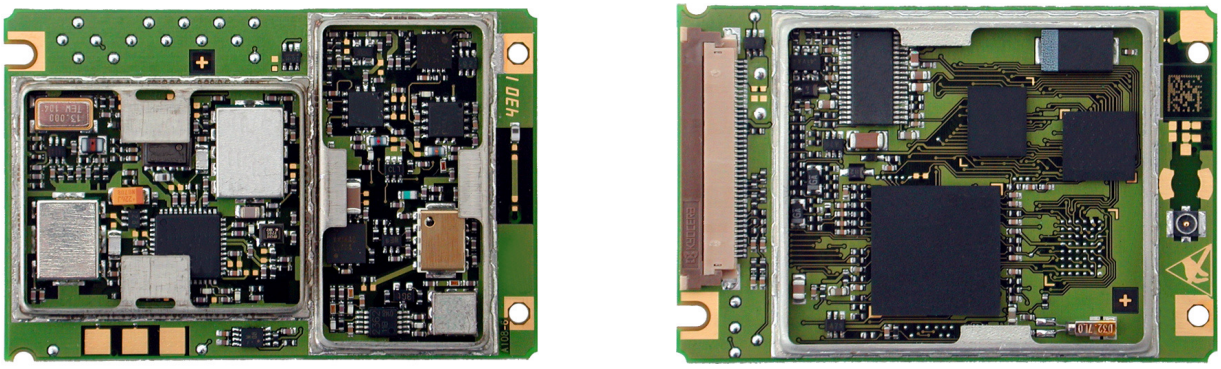


Figure 2: MC35 GSM/GPRS Engine

2.4 Operating modes

The table below briefly summarizes the various operating modes referred to in the following chapters.

Table 4: Overview of operating modes

Mode	Function	
Power Down	The Terminal is switched off. Operating voltage applied. Only a voltage regulator in the Power Supply ASIC is active for powering the RTC. Software is not active. The RS-232 interface is not accessible.	
Normal operation	GSM / GPRS SLEEP	Powersave modes set with AT+CFUN command. Software is active to minimum extent. If the module was registered to the GSM network in IDLE mode, it is registered and paging with the BTS in SLEEP mode, too. Power saving can be chosen at different levels: The NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The two CYCLIC SLEEP modes AT+CFUN=5 or 6 alternatingly activate and deactivate the AT interface to allow permanent access to all AT commands. See Chapters 2.5.2 and 2.5.3.
	GSM IDLE	Software is active. Once registered to the GSM network, paging with BTS is carried out. The Terminal is ready to send and receive.
	GSM TALK	Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
	GPRS IDLE	Terminal is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. multislot settings).
	GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multislot settings).

2.5 Terminal circuit

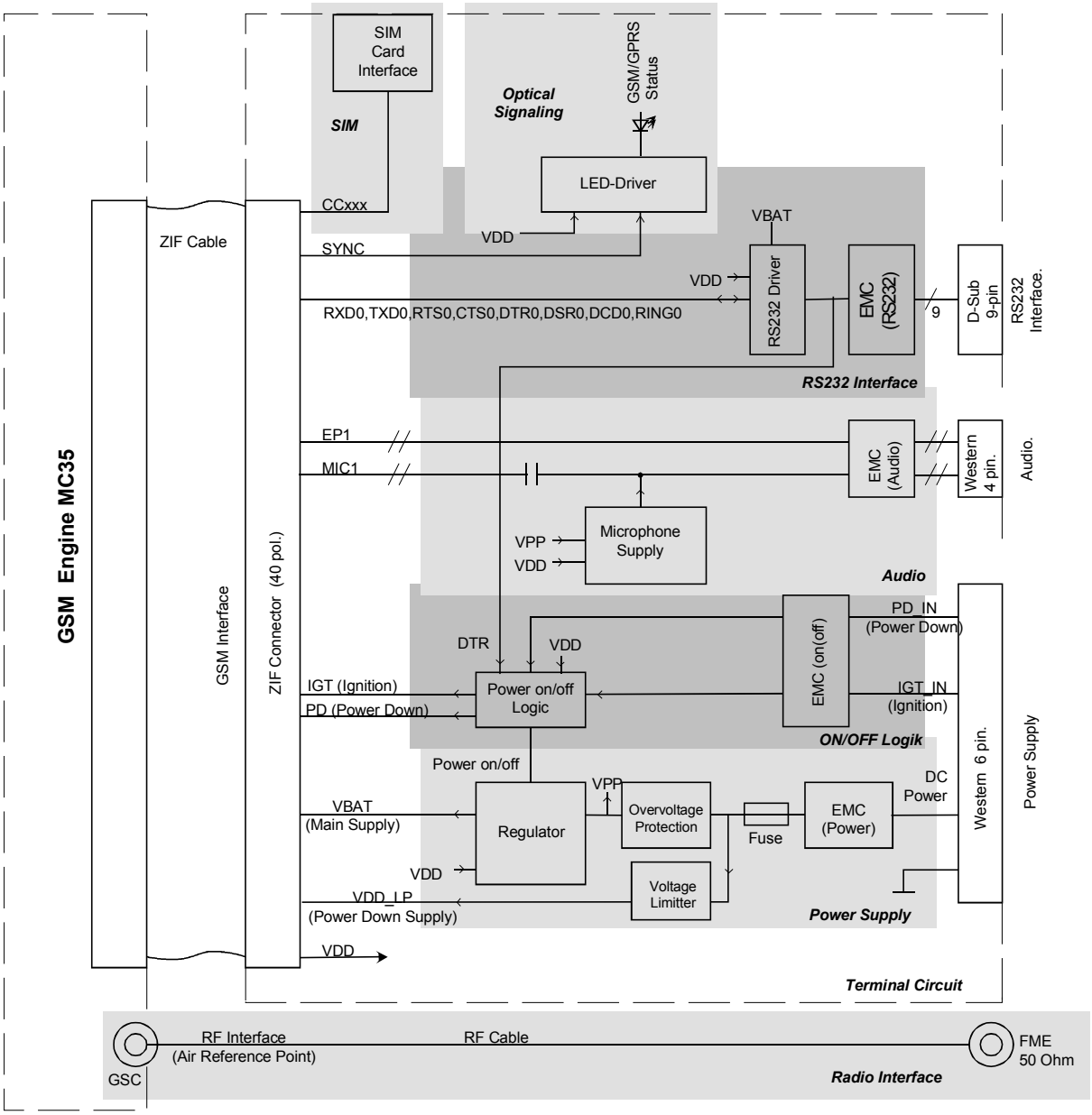
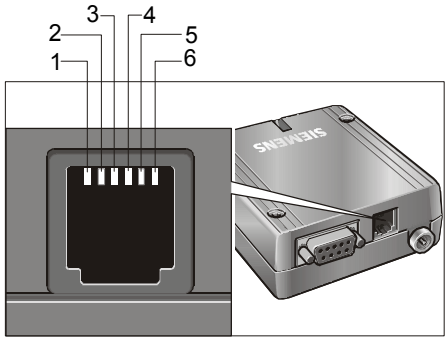


Figure 3: MC35 Terminal circuit block diagram

2.5.1 Power supply and On-Off control

- A switching regulator regulates the input voltage for the internal supply. In Power Down mode the switching regulator is turned off by the On/Off logic.
- A separate voltage limiter supplies the real time clock in the MC35 Engine.
- The Terminal is protected from supply voltage reversal and overvoltage.
- The internal fuse is not removable, it is only for electrical safety according to EN60950.
- EMC immunity complies with the vehicular environment requirements according ETS 300 342-1 (exceptions see note 1).



Pin assignment:

1 +
2 free
3 PD_IN
4 IGT_IN
5 free
6 GND

Figure 4: Female 6-pole Western plug for power supply, ignition, power down

Mains adapter:

It is recommended to use the adapter of the type approval reference configuration. Ordering information can be found in [2]. This 12V mains adapter comes with a 6 pole Western plug and features an internal connection between IGT_IN pin and PLUS pin for auto ignition (power up).

Table 5: Female 6-pole Western plug for power supply, ignition, power down

Pin	Signal Name	Use	Parameters
1	PLUS	Power supply (see Note 1)	8V - 30V DC, max. 33V for 1 min
2	Free	---	---
3	PD_IN	Signal for power down mode (see Note 2)	U_{IH} ≥5V for t > 3,5s U_{IL} <2V
4	IGT_IN	Ignition (see Note 3)	U_{IH} ≥5V Ignition ≥ 5V for more than 200ms switches the terminal on
5	Free	---	---
6	GND	Ground	0V

Note 1:

- To protect the device from high voltages (>30V) a 1.25A quick-break fuse on pin 1 of the 6-pole Western plug shall be used. For use with power packs and batteries observe the EN60950 guidelines. Installation and start-up may only be performed by authorised persons.
- The power supply of the MC35 Terminal has to be a single voltage source of V_{PLUS}+ = 8V...30V providing a peak current (pulsed 577ms at T=4,615ms) of about 1,2A at 12V during the active transmission. The uplink bursts cause strong ripple (drops) on the power lines. The drop voltage should not exceed 1V, but the absolute minimum voltage during drops must be >7.6V.
- The power supply shall be compliant with the SELV safety standard defined in EN60950.
- When power fails for >1ms, MC35T resets or switches off.
  When power fails for >7s, the real time clock will be reset.

Note 2:

- To turn off MC35 Terminal use the AT^SMSO command, rather than disconnecting the mains adapter.
  This procedure lets MC35 Terminal log off from the network and allows the software to enter into a secure state and to save data before disconnecting the power supply. Before switching off the device sends the result code
  ^SMSO: MS is OFF
  The green status LED stops flashing. The RTC is still fed from the voltage regulator in the power supply ASIC. This mode is referred to as Power Down mode.
- Emergency shutdown: In the event of software hang-ups etc. the MC35T can be switched off by applying a voltage >5V to pin 3 for more than 3.5s.
  To switch on again you have two options: Activate the ignition pin (IGT_IN pin 4) or switch on the RS-232 DTR line, while the PD_IN pin is not active (pin 3 voltage <2V).
  The PD_IN signal switches the terminal off. All internal supply voltages are off, except for the power down voltage, which still feeds the real-time clock (RTC). See Note 4 for use of the RTC.
- For all other operating modes the PD_IN signal must be low (<2V).
- When MC35T enters the Power Down mode, e.g. after you have issued the AT^SMSO command or activated the PD_IN signal, all RS-232 interface lines are active for a period of 50ms to max. 3.5s. This may cause undefined characters to be transmitted on the RS-232 lines which can be ignored.

Caution: *Use the PD_IN pin only when, due to serious problems, the software is not responding for more than 5 seconds. Pulling the /PD pin causes the loss of all information stored in the volatile memory since power is cut off immediately. Therefore, this procedure is intended only for use in case of emergency, e.g. if MC35 Terminal fails to shut down properly.*

Note 3:

- The ignition is activated only by a rising edge. The rise time is <20ms.
- The IGT_IN signal switches the terminal on (it changes from Power Down state to the net searching state).

Note 4:

The RTC retains the time and controls the alarm function. For example, you can set a reminder call using the AT+CALA command. Once the specified time is reached, the alarm will be executed. See [3] for detailed instructions. However, please note that the Alarm mode described in [3] is not intended for MC35T. Therefore, it is not recommended to power down MC35T after setting an alarm.
If nevertheless MC35T goes into Power Down mode or is switched off though an alarm has been set, pay attention to the following change in the start-up procedure: The alarm does not wake up MC35T from Power Down mode. Yet, MC35T will enter the so-called Alarm mode when you attempt to switch it on once again (using IGT) after the alarm time was exceeded.

The Alarm mode allows only restricted operation: The AT interface is not fully accessible, i.e. only a limited number of AT commands can be used. To start up MC35T to full operation you are required to switch IGT once again.

The Alarm mode is indicated by an unsolicited result code (URC) that reads "SYSSTART ALARM MODE". If autobauding was activated, this URC will not be output – as a result you might not be aware of the Alarm mode.

If you switch MC35T on before the alarm time is reached, MC35T starts up as usual.

2.5.2 Power saving

SLEEP mode reduces the functionality of the MC35 module to a minimum and, thus, minimizes the current consumption to the lowest level. SLEEP mode is set with the AT+CFUN command and can be selected in the three levels <fun>=0, 5 or 6. Detailed instructions of how to handle the AT+CFUN command are provided in [3].

IMPORTANT: The AT+CFUN command can be executed before or after entering PIN1. Nevertheless, please keep in mind *that power saving works only while the module is registered to the GSM network*. If you attempt to activate power saving while the module is detached, the selected <fun> level will be set, though power saving does not take effect.

The status LED stops flashing once the module starts power saving.

2.5.2.1 NON-CYCLIC SLEEP mode (AT+CFUN=0)

If level 0 has been selected, the serial interface is blocked. The module shortly wakes up to listen to a paging message block sent from the base station and immediately returns to the power saving mode.

The first wake-up event fully activates the module, enables the serial interface and terminates power saving. Level 0 is called NON-CYCLIC SLEEP mode.

2.5.2.2 CYCLIC SLEEP mode (AT+CFUN=5 or 6)

These two options are referred to as CYCLIC SLEEP modes. The major benefit over the NON-CYCLIC SLEEP mode is that the serial interface is not permanently blocked and that packet switched calls may go on without terminating the power saving mode. This allows you to take advantage of power saving, for example, while the GSM engine remains attached to the GPRS and even performs a GPRS data transfer.

The CYCLIC SLEEP mode is a dynamic process, which alternatingly enables and disables the serial interface. The application must be configured to use hardware flow control. By setting/resetting the CTS signal, the module indicates to the application when the UART is active. The application must wait until CTS is set (i.e. is active low) on the physical UART before data can be sent to the module. See also Chapter "RS-232 interface", page 24.

The module starts or resumes power saving two seconds (AT+CFUN=5) or ten minutes (AT+CFUN=6) after the last sent or received character. The module resets the CTS signal, and after additional 5ms it physically deactivates the UART to save power. See Figure 6.

Wake-up procedures are the same as in the NON-CYCLIC SLEEP mode. The first wake-up event fully activates the module, enables the serial interface and terminates power saving. As an additional option, you can set AT+CFUN=1 to wake up the module.

2.5.2.3 Timing of the CTS signal in CYCLIC SLEEP modes

The CTS signal is enabled in synchrony with the module's paging cycle. It goes active low each time when the module starts listening to a paging message block from the base station. The timing of the paging cycle varies with the base station and can be determined by the following formula:

*4.615 ms (TDMA frame duration) * 51 (number of frames) * DRX value*.

DRX (Discontinuous Reception) is a value from 2 to 9, resulting in paging intervals from 0.47 to 2.12 seconds. The precise DRX value of the base station can be requested from the network operator.

If DRX ≥ 3, i.e. if paging is performed at intervals from 0.71 to 2.12 seconds, each listening period causes the CTS signal to go active low. If DRX is 2, i.e. if paging is done every 0.47 seconds, the CTS signal is activated with every 2nd listening period.

The CTS signal stays active low for 20 ms. This is followed by another 5 ms UART activity. Thus, once the CTS signal goes active low, you have 25 ms to enter characters. In the pauses between listening to paging message blocks, while CTS is high, the module resumes power saving and the AT interface is not accessible. See Figure 5.

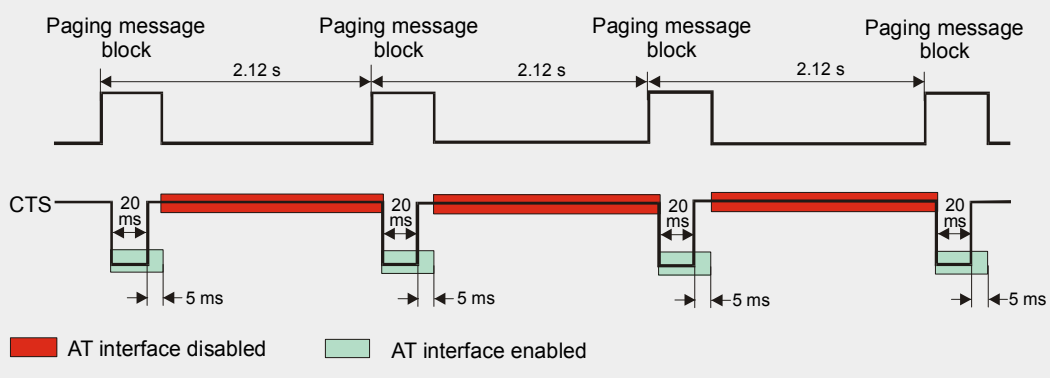


Figure 5: Timing of CTS signal (example for a 2.12 s paging cycle)

Figure 6 illustrates the CFUN=5 mode, which resets the CTS signal 2 seconds after the last character was sent or received. The UART is kept active for another 5 ms before power saving begins.

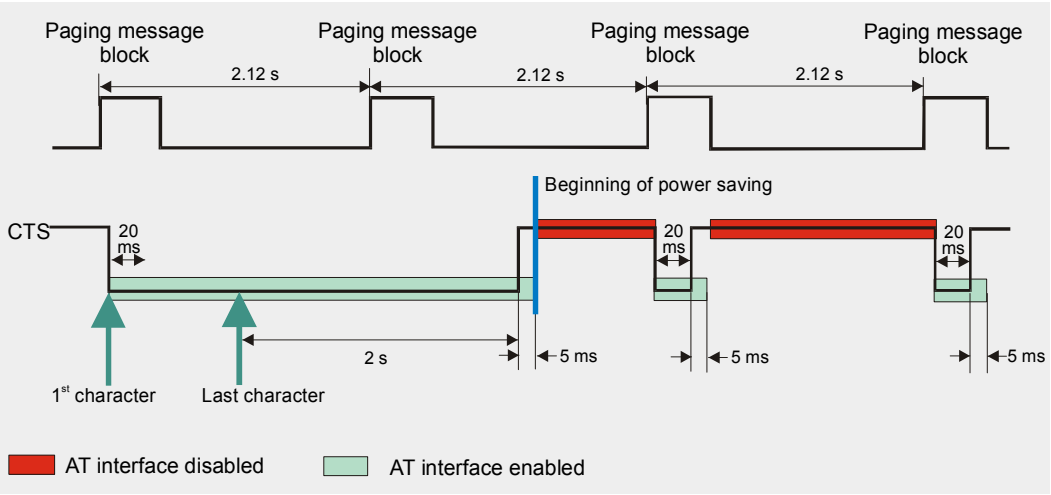


Figure 6: Beginning of power saving if CFUN=5

2.5.3 Wake up GSM engine

The following table summarizes the options of waking up the GSM engine from SLEEP or Power Down mode.

Table 6: Wake-up events

GSM engine is registered to GSM network		
How to wake up	From SLEEP mode AT+CFUN=0	From SLEEP mode AT+CFUN=5 or 6
Ignition line	No	No
RTS (falling edge)	Yes	No
Unsolicited Result Code (URC)	Yes	Yes
Incoming call	Yes	Yes
Incoming SMS depending on mode selected by AT+CNMI:		
AT+CNMI=0,0 (= default, no indication upon receipt of SMS)	No	No
AT+CNMI=1,1 (= displays URC upon receipt of SMS)	Yes	Yes
RTC alarm	Yes	Yes
AT+CFUN=1	No (UART disabled)	Yes
GSM engine is detached from GSM network		
How to wake up	From Power Down mode	
Ignition line (IGT_IN)	Yes	
RTS (falling edge)	No	
Unsolicited Result Code	No	
Incoming call	No	
RTC alarm	No	

2.5.4 RS-232 interface

Via RS-232 Interface, the host controller controls the MC35 Terminal and transports data.

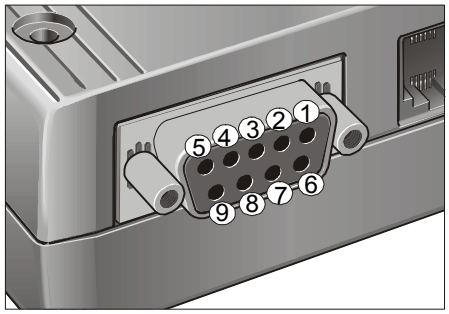


Figure 7: Pin assignment RS-232 (D-Sub 9 pole female)

EMC immunity complies with the vehicular environment requirements according to ETS 300 342-1

Table 7: 9-pole D-Sub (female) RS-232

Pin no.	Signal name	I/O	Function
1	DCD	O	Data Carrier Detected
2	RXD	O	Receive Data
3	TXD	I	Transmit Data
4	DTR	I	Data Terminal Ready Attention: The ignition of MC35 Terminal is activated via a rising edge of high potential (+5 ... +15 V)
5	GND	-	Ground
6	DSR	O	Data Set Ready
7	RTS	I	Request To Send
8	CTS	O	Clear To Send
9	RI	O	Ring Indication

The current of all signals is limited by serial resistors:
Outputs: 470 Ohm
Inputs: 1kOhm

MC35T is designed for use as a DCE. Based on the conventions for DCE-DTE connections it communicates with the customer application (DTE) using the following signals:

- Port TxD @ application sends data to TXD of MC35T
- Port RxD @ application receives data from RD of MC35T

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS-232 Interchange Circuits DCE. It is configured for 8 data bits, no parity and 1 stop bit, and can be operated at bit rates from 300bps to 115kbps. Autobauding

supports the following bit rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps. Hardware handshake using the RTS and CTS signals and XON/XOFF software flow control are supported.

In addition, the modem control signals DTR*), DSR, DCD and RING are available. The modem control signal RING (Ring Indication) can be used to indicate, to the cellular device application, that a call or Unsolicited Result Code (URC) is received. There are different modes of operation, which can be set with AT commands.

*) **The DTR signal will only be polled once per second from the internal firmware of MC35.**

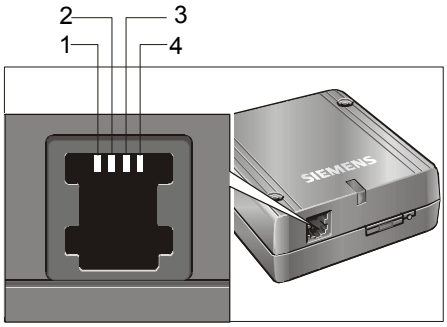
2.5.5 Audio interface

The audio interface provides an analog input for a microphone and an analog output for an earpiece.

- The microphone input and the earpiece output are balanced.
- For electret microphones a supply source is implemented.
- The microphone supply characteristics are optimized for the recommended handset. (Votronic HH-SI-30.3/V1.1/0. For ordering Information see [1] and [2]).
- This handset has been used as the reference handset for type approval. An extra approval must be obtained for integrating other handsets or amplifiers.

The amplification of sending direction, receiving direction and sidetone depend on the current audio mode.

EMC immunity complies with the vehicular environment requirements according to ETS 300 342-1.



Pin assignment:

1	**MICN (Microphone -)**
2	**EPN (Earpiece)**
3	**EPP (Earpiece)**
4	**MICP** (Microphone +)

Figure 8: Audio Western plug (4 pole female)

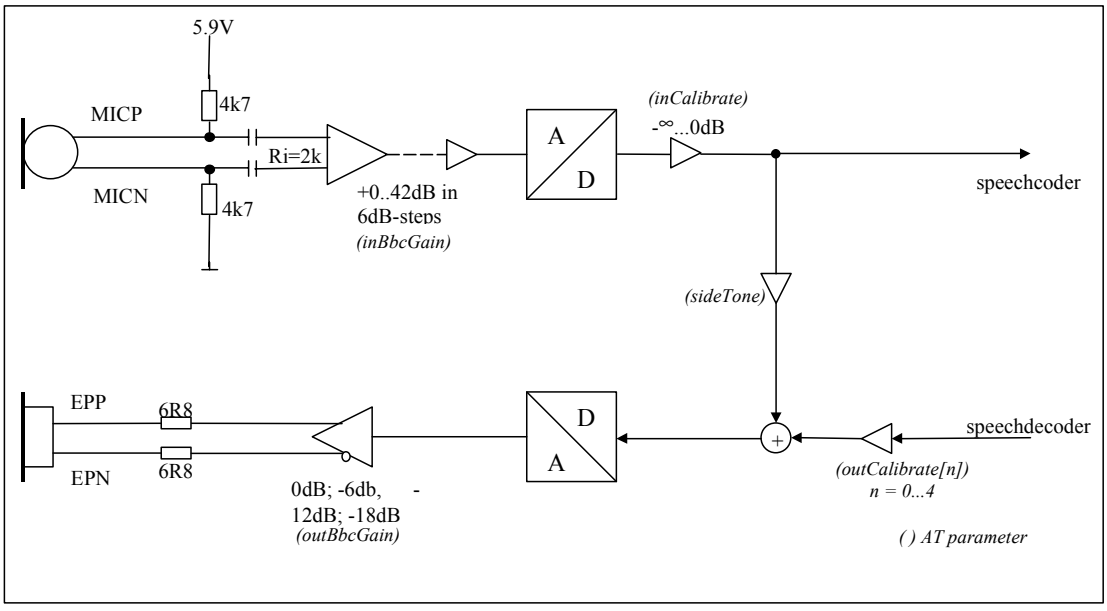


Figure 9: Audio block diagram

2.5.5.1 Supported audio modes

The audio interface can be configured by AT commands. For detailed instructions on using AT commands please refer to [3].

The electrical characteristics of the voiceband part vary with the audio mode. To suit several types of audio equipment, there are three modes available which can be selected by the AT command AT^SNFS. In audio mode 4 and 5, the gain in the microphone, earpiece and the sidetone path can be adjusted from the cellular device application (different volume steps can be selected by AT commands). See Table 17: AT adjustable parameters for the characteristics of the audio modes.

Table 8: Audio Modes

Mode No AT^SNFS=	1 (Default settings, not adjustable)	4	5
Name	Default Handset	User Handset	Plain Codec 1
Purpose	Recommended handset (see chapter 6)	Individual handset	Direct access to speech coder
Gains programmable via AT command	Not adjustable	Adjustable	Adjustable
Supply	ON	ON	OFF
Sidetone	ON, but not adjustable	Adjustable	Adjustable
Volume control	Not adjustable	Adjustable	Adjustable
Limiter (receive)	ON	ON	---
Compressor (receive)	---	---	---
Echo control (send)	Suppression	Suppression	---
Noise suppression[1)]	up to 10 dB	up to 10 dB	---
MIC input signal for 0dBm0 @ 1024 Hz (at default gain settings)	12.5 mV	12.5 mV	315 mV
Earpiece output signal in mV eff. @ 0dBm0, 1024 Hz, no load (at default gain settings); @ 3.14 dBm0	275 mV	275 mV default @ max volume	880 mV 3.7 Vpp
Sidetone gain (at default settings)	27.7 dB	27.7 dB	-2.7dB at sideTone = 8192 [2)]

1) In audio modes with noise reduction, the microphone input signal for 0dBm0 shall be measured with a sine burst signal for a tone duration of 5 seconds and a pause of 2 sec. The sine signal appears as noise and, after approx. 12 sec, is attenuated by the noise reduction by up to 10dB.

2) See AT^SNFO command in [3].

2.5.5.2 Additional audio modes

Though selectable with the AT^SNFS command, the modes 2, 3, and 6 are not enabled on an MC35 Terminal. When you attempt to set one of these modes no changes will take effect.

To benefit from mode 2, 3 or 6, for example for use with a handsfree device or a headset, you are required to take further actions:

a) Ensure that the accessories can be connected to the audio interface of MC35 Terminal, for example you may need an appropriate adapter.
b) The default audio parameters of MC35 Terminal need be replaced with customized parameters. For this purpose, you will need a downloadable parameter set, which can be generated by Siemens AG according to your particular audio application design.
   Please note that this service is available on request. For detailed information on costs and requirements please contact your local distributor or Siemens AG. Basic requirements are outlined in [10].

2.5.5.3 Speech processing

The voiceband filter includes a digital interpolation low-pass filter for received voiceband signals with digital noise shaping and a digital decimation low-pass filter for voiceband signals to be transmitted.

After voiceband (interpolation) filtering the resulting 2Mbit/s data stream is digital-to-analog converted and amplified by a programmable gain stage in the voiceband processing part. The output signal can directly be connected to the earpiece of the GSM cellular device or to an external handset earpiece (via I/O connector). In the opposite direction the input signal from the microphone is first amplified by a programmable amplifier. After analog-to-digital conversion a 2Mbit/s data stream is generated and voiceband (decimation) filtering is performed.

The resulting speech samples from the voiceband filters are handled by the DSP of the baseband controller to calculate e.g. amplifications, sidetone, echo cancellation or noise suppression.

Full rate, half rate and enhanced full rate, speech and channel encoding including voice activity detection (VAD) and discontinuous transmission (DTX) and digital GMSK modulation are also performed on the GSM baseband processor.

Note: With regard to acoustic shock, the cellular application must be designed to avoid sending false AT commands that might increase the amplification, e.g. for a high sensitive earpiece.

2.5.6 Radio interface

An internal antenna cable adapts the Air Reference Point (ARP) (antenna connector type GSC from Murata) to the FME (male) connector.

- Cable loss of internal cable
  <0.7dB @ 900MHz
  <1.4dB @ 1800MHz
- The system impedance is 50Ω.
- In every case, for good RF performance the return loss of the customer application should be better than 10dB (VSWR < 2).
- MC35 Terminal withstands a total mismatch at this connector when transmitting with power control level for maximum RF Power.

EMC immunity complies with the vehicular environment requirements according to ETS 300 342-1.

For the application it is recommended to use an antenna with the following FME (female) connector:

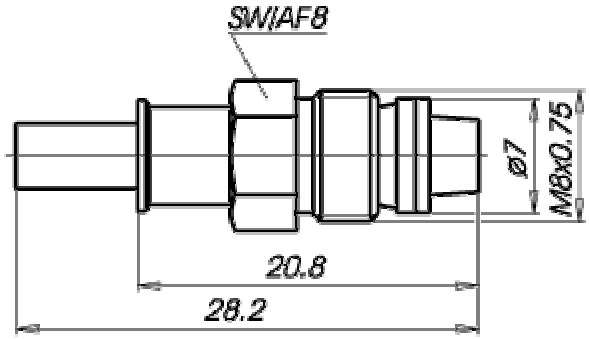
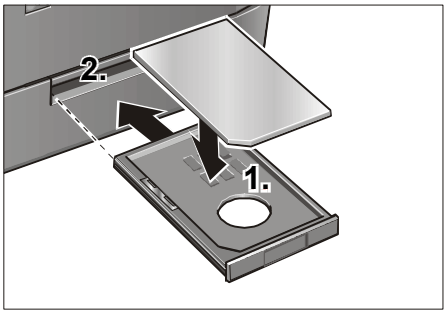


Figure 10: Recommended Antenna Connector

2.5.7 SIM interface

The SIM interface is intended for 3V SIM cards in accordance with GSM 11.12 Phase 2. The card holder is a five wire interface according to GSM 11.11. A sixth pin has been added to detect whether or not a SIM card is inserted.



All signals of the SIM interface are protected from electrostatic discharge with spark gaps to GND and clamp diodes to 2.9V and GND.

MC35 Terminal offers two different solutions for upgrading firmware. In most cases, you can upgrade the firmware via the RS-232 interface. However, if your application does not allow access to the serial interface you can use the SIM interface instead. To avail of the SIM option, you will need to purchase a special adapter named BB35 BootBox. Click http://www.siemens.com/wm for further details and ordering information, or please consult your local Siemens dealer. Chapter 5 briefly summarizes the supported options.

2.5.8 Status LED

A green LED displays the operating status of the terminal:

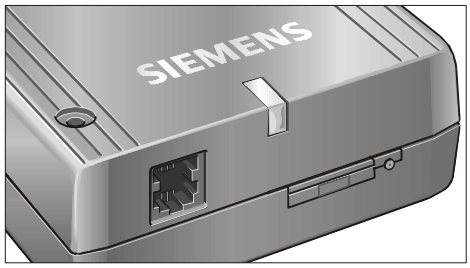


Table 9: Coding of the green status LED

LED mode	Operating status
Off	Power Down mode or SLEEP mode (registered to the net)
600 ms On / 600ms Off	No SIM card inserted or no PIN entered, or network search in progress, or ongoing user authentication, or network login in progress.
75 ms On / 3 s Off	Logged to network (monitoring control channels and user interactions). No call in progress.
75 ms on / 75 ms Off / 75 ms On / 3 s Off	One or more GPRS contexts activated.
Flashing	Indicates GPRS data transfer: When a GPRS transfer is in progress, the LED goes on within 1 second after data packets were exchanged. Flash duration is approximately 0.5 s.
On	Depending on type of call: *Voice call:* Connected to remote party. *Data call:* Connected to remote party or exchange of parameters while setting up or disconnecting a call.

3 Mechanical characteristics

Table 10: Mechanical characteristics

Weight	130 g
Dimensions (max) LxWxH =	65x74x33mm
Temperature range	-20°C to +55 °C
Protection class	IP40 (Avoid exposing MC35 Terminal to liquid or moisture, for example do not use it in a shower or bath.)
Mechanical vibrations Amplitude	7.5 mm at 5-200 Hz sinus
Max. pulse acceleration	30g pulse with 18 ms duration time
Air humidity	5...98% (non condensing)
Class of flammability	UL94 HB
Casing material	PC/ABS Cycoloy 1200 HF grey 96444

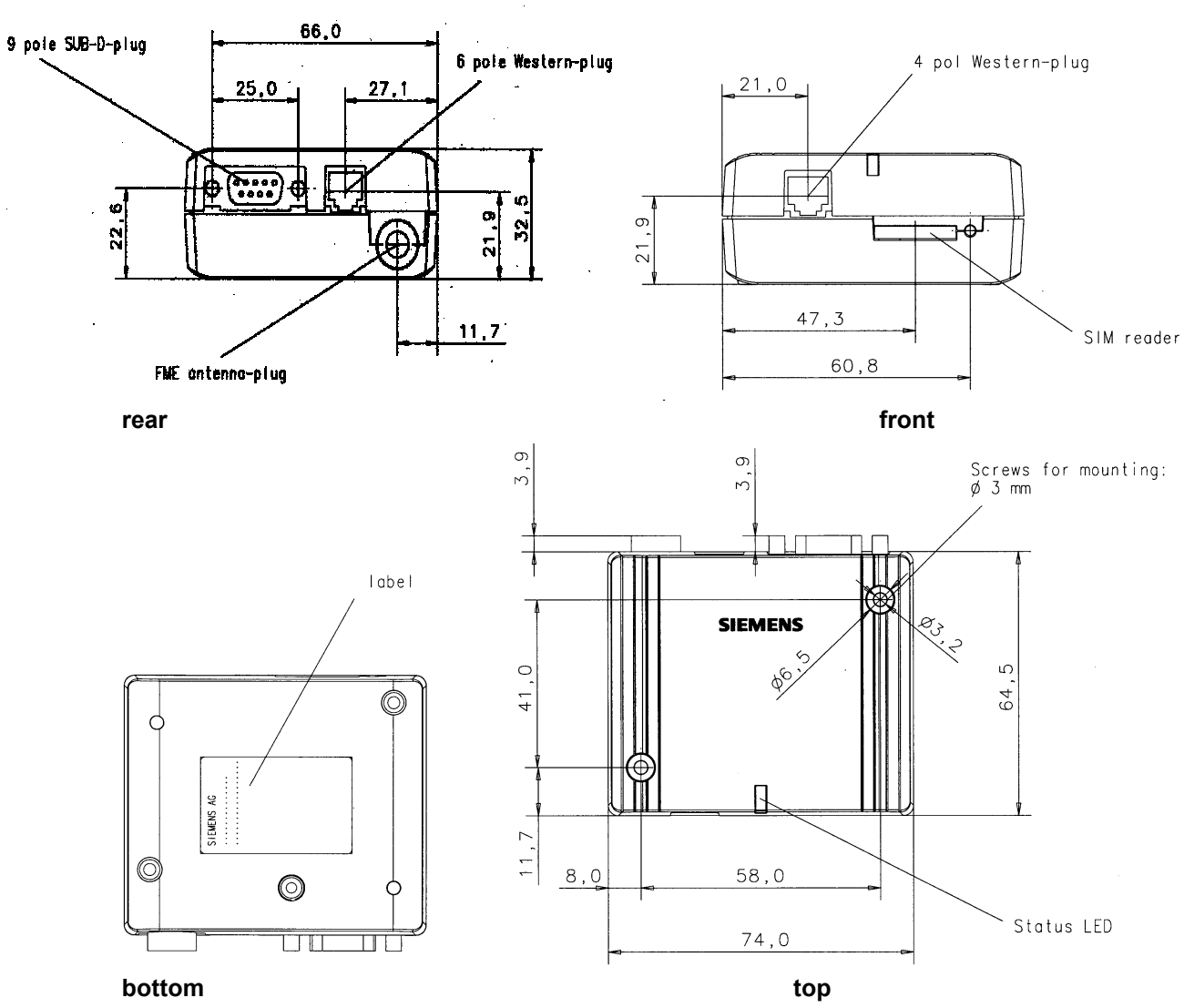


Figure 11: Design drawing

3.1 Label marking

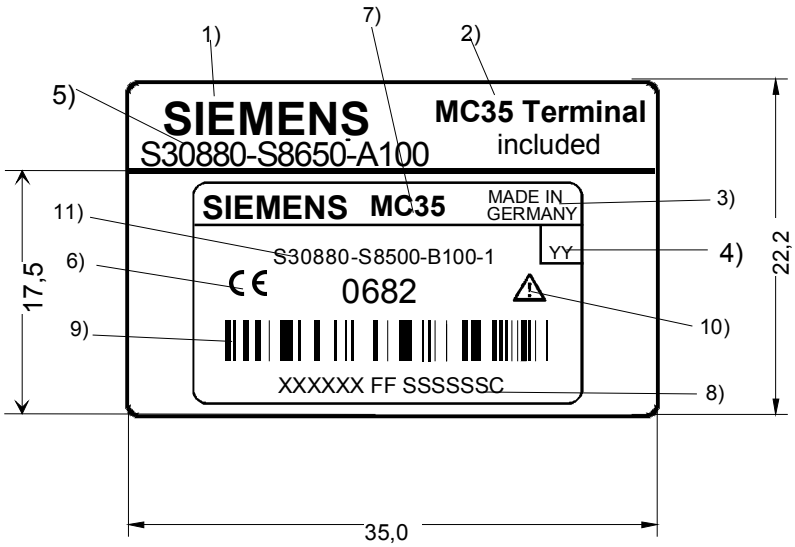


Figure 12: Label marking

1) Company Name
2) Product Name
3) Made in Germany
4) Date code
5) Code number
6) CE-Sign
7) Short name of the included GSM Engine
8) Normal character IMEI number

XXXXXX	Type Approval Code:
FF	Final Assembly Code:41
SSSSSS	6 digit serial number = Bar Code (normal character) provided through PICS
C	Check Digit

9) Barcode IMEI Number
10) Note triangle
11) Code number of the included GSM Engine

4 Electrical and environmental characteristics

Table 11: Absolute maximum ratings

Parameter	Port / Description	Min.	Max.	Unit
Supply voltage	PLUS	-63	30	V
Overvoltage	PLUS / for 1h		33	V
Input voltage for on/off Control lines	IIGT_IN, PD_IN	-5	30	V
RS-232 input voltage range	TXD, DTR, RTS	-30	+30	V
	RXD,CTS,DSR,DCD,RING	-0.3	+5.3	V
Microphone input line voltage	MICP, MICN	-0,3	+10	V
Earpiece input voltage	EPP, EPN	-0.3	+3.3	V
Storage temperature		-40	+85	°C
Electro static air discharge immunity against distortion	all connectors (lines)	-8	+8	kV
Air humidity	no condensed		98	%
Protection Class	IP40 (avoid exposing MC35 Terminal to liquid or moisture, for example do not use it in a shower or bath)		IP 40	
Mechanical vibrations amplitude	@ 5-200Hz		7.5	mm
Mechanical pulse-acceleration	@ 18 ms duration		30	g

Table 12: Operating conditions

Parameter	Min	Typ	Max	Unit
Ambient temperature	-20	25	55	°C
Supply voltage PLUS measured at (6 pole) western jack pin (1 to 6)	7.6 lowest voltage (minimum peak) incl. all ripple and drops	12	30	V

Table 13: Characteristics Power supply

Parameter	Description	Conditions		Min	Typ	Max	Unit
V_{PLUS}	Allowed voltage ripple (peak-peak), drop during transmit burst peak current	1) Talk Mode, power control level for P_{out} max				1	V
I_{PLUS} 2)	Average supply current (average time 3 min.)	Power Down mode	@8V		480	550	µA
			@12V		700	800	
			@30V		1750	1850	
		SLEEP mode (GSM/GPRS)	@8V		45	47	mA
			@12V		30	33	
			@30V		17	19	
		NET Searching mode (NO NET)	@8V		60	120	mA
			@12V		40	80	
			@30V		22	44	
		IDLE mode (GSM/GPRS)	@8V		50	60	mA
			@12V		35	45	
			@30V		20	30	
		GSM TALK mode	@8V		270	310	mA
			@12V		170	200	
			@30V		72	82	
		GPRS DATA mode (Links: 3Down, 1UP)	@8V		290	320	mA
			@12V		180	210	
			@30V		77	85	
	Peak supply current (during 577µs transmission slot every 4.6ms)	Power control level for Pout max	@8V		1.7	1.8	A
			@12V		1.2	1.4	
			@30V		0.7	0.8	
$t_{PLUS-Fail}$	Allowed powerfail time without terminal reset or power down	After this time the Terminal will be reset or switched off				1	ms
	Allowed powerfail time without RTC (real time clock) reset	After this time the RTC will be reset				7	s
t_{R_PLUS}	Allowed rise time of V_{PLUS}	0% to 100%				20	ms
LE_{Cable}	Length of supply cable					3	m

1) Lowest voltage (minimum peak) incl. all ripple and drops >7.6V, measured at western jack (6 pole) pin (1 to 6)
2) Further conditions: Load at all RS232 output lines: 5kOhm
Antenna impedance = 50Ohm (return loss >20dB)

All values established under worst case conditions

Table 14: Characteristics (Requirements) On/Off Control lines

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{high}	Input voltage	active high	5			V
V_{low}	IGT_IN, PD_IN, DTR				2	V
R_{IN}	Input resistance of IGT_IN, PD_IN		47			kOhm
R_{IN}	Input resistance of DTR		4	6	8	kOhm
t_{D_IGT} , t_{D_DTR}	Duration of active high IGT_IN, DTR		200			ms
t_{D_PD}	Duration of active high PD_IN		3.5			s
t_{R_IGT}	Rise time IGT_IN for power up	0% to 100%			20	ms
t_{R_DTR}	Rise time DTR for power up	0% to 100%			20	ms
$t_{D\_passive}$	Duration passive (low) of IGT_IN, DTR before restart	after power down	1			s

Table 15: Characteristics (Requirements) RS-232 Interface

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{OUT}	Transmitter Output Voltage for RXD,CTS,DSR,DCD, RING	@ 5kOhm load	±5	±6	±7	V
R_{OUT}	Transmitter Output Resistance RXD,CTS,DSR,DCD, RING				770	Ohm
R_{IN}	Receiver Input Resistance TXD,RTS,DTR		4	6	8	kOhm
V_{RIHYS}	Input Hysteresis		0.2	0.5	1	V
V_{Ilow}	Input Threshold Low		1.0	1.8		V
V_{Ihigh}	Input Threshold High			2.4	3	V
Baudrate		Autobauding	4.8		115	kbps
		Fixed range	300bps		115	kbps
LE_{Cable}	Length of RS-232 cable			1.8	2	m

Table 16: Characteristics (Requirements) Audio Interface

Parameter		Min.	Typ.	Max.	Unit
Microphone	DC (no load) at MICP	5.6	5,9	6,2	V
MICP, MICN	DC at MICP in POWER DOWN		0		V
	DC (no load) at MICN		0		V
	DC Resistance differential MICN, MICP (balanced)	9.3	9.4	9.5	kOhm
	Impedance Z_i (balanced)	1.4	1.5	1.7	kOhm
	Input level U_{imax}			1.03	V_{PP}
	Gain range 6 dB steps	0		42	dB
	Frequency Range	300		3400	Hz
Earpiece EPP, EPN	fine scaling by DSP (inCalibrate)	-∞		0	dB
	Impedance (audio not active)		30		kOhm
	Impedance (balanced)		15		Ohm
	AC output level U_O *Gain* = 0dB @ 3.14 dBm0 no load audio mode = 5, outBbcGain = 0, outCalibrate = 32767	3.3	3.7	4.07V	V_{PP}
	Gain range	-18		0	dB
	Gain accuracy			0.8	dB
	Frequency area	300		3400	Hz
	DC Offset (balanced)			100	mV
	Attenuation distortion for 300...3900Hz			1	dB
	Out-of-band discrimination	60			dB
LE_{Audio}	Length of Audio (Handset) cable			3	m

Unless otherwise stated, all specified values are valid for gain setting (*gs*) 0dB and 1kHz test signal.
gs = 0dB means audio mode = 5 for EPP to EPN, inBbcGain= 0, inCalibrate = 32767, outBbcGain = 0, OutCalibrate = 16384, sideTone = 0.

Audio Modes:
The electrical characteristics of the voiceband part depend on the current audio mode selected by the AT command AT^SNFS. See Table 8: Audio Modes.

The audio modes 4 and 5 can be adjusted by parameters. Each audio mode is assigned a separate parameter set.

Table 17: AT adjustable parameters

Parameter	Influence to	Range	Gain range	Calculation
inBbcGain	MICP/MICN analogue amplifier gain of baseband controller before ADC	0...7	0...42dB	6dB steps
inCalibrate	digital attenuation of input signal after ADC	0...32767	-∞...0dB	20 * log (inCalibrate/ 32768)
outBbcGain	EPP/EPN analogue output gain of baseband controller after DAC	0...3	0...-18dB	6dB steps
outCalibrate[n] n = 0...4	digital attenuation of output signal after speech decoder, before summation of sidetone and DAC present for each volume step[n]	0...32767	-∞...+6dB	20 * log (2 * outCalibrate[n]/ 32768)
sideTone	digital attenuation of sidetone is corrected internally by outBbcGain to obtain a constant sidetone independently to output volume	0...32767	-∞...0dB	20 * log (sideTone/ 32768)

Note: The inCalibrate, outCalibrate and sideTone accept also values from 32768 to 65535. These values are internally truncated to 32767.

Table 18: Characteristics Air Interface

Parameter		Min	Typ	Max	Unit
Frequency range	E-GSM 900	880		915	MHz
Uplink (MS → BTS)	GSM 1800	1710		1785	MHz
Frequency range	E-GSM 900	925		960	MHz
Downlink (BTS → MS)	GSM 1800	1805		1880	MHz
RF power @ ARP with 50Ω load	E-GSM 900	Class 4			
	GSM 1800	Class 1			
Number of carriers	E-GSM 900		174		
	GSM 1800		374		
Duplex spacing	E-GSM 900		45		MHz
	GSM 1800		95		MHz
Carrier spacing			200		kHz
Multiplex, Duplex		TDMA / FDMA, FDD			
Time slots per TDMA frame			8		
Time slots usable RX / TX (GSM Mode)				1 / 1	
Time slots usable RX / TX (GPRS Mode)				3 / 1	
Frame duration			4.615		ms
Time slot duration			577		µs
Modulation		GMSK			
Receiver input sensitivity @ ARP BER Class II < 2.4%	E-GSM 900	-102			dBm
	GSM 1800	-102			dBm
Length of antenna cable				3	m

5 Updating MC35 Firmware

The MC35 firmware is stored in a Flash memory. This gives you the flexibility to easily upgrade to the latest firmware releases. The firmware is supplied as a Windows executable that can be downloaded onto MC35 Terminal using the serial interface of its ZIF connector or the SIM interface.

Updating the firmware over the serial interface

- The download procedure uses the TXD0, RXD0 and IGT lines of the ZIF connector and the TXD, RXD and DTR lines of the host application (MMI) or the PC's serial port.

Updating the firmware over the SIM interface

- This solution is recommended when your GSM application has no direct access to a serial interface. To transfer the software to the device you will need the BB35 Bootbox. It comes with a specific adapter that connects the SIM card reader of your MC35 application to your computer's serial port.
- IMPORTANT: Please note that this solution is only applicable to MC35 modules as of firmware release 02.00. Earlier releases shipped as engineering or working samples until firmware version 01.01 must be updated over the serial interface first, and are then ready for further updates over the SIM interface.

In either case, the firmware executable runs on any computer under Windows 98, Windows NT 4.0, Windows 2000, Windows ME, Windows XP (except for Windows 95 which supports only the serial interface option).

For detailed information and step-by-step instructions please refer to [6].

6 Full type approval

The MC35 Terminal has been approved for a reference configuration that complies with the requirements of GSM Phase 2/2+

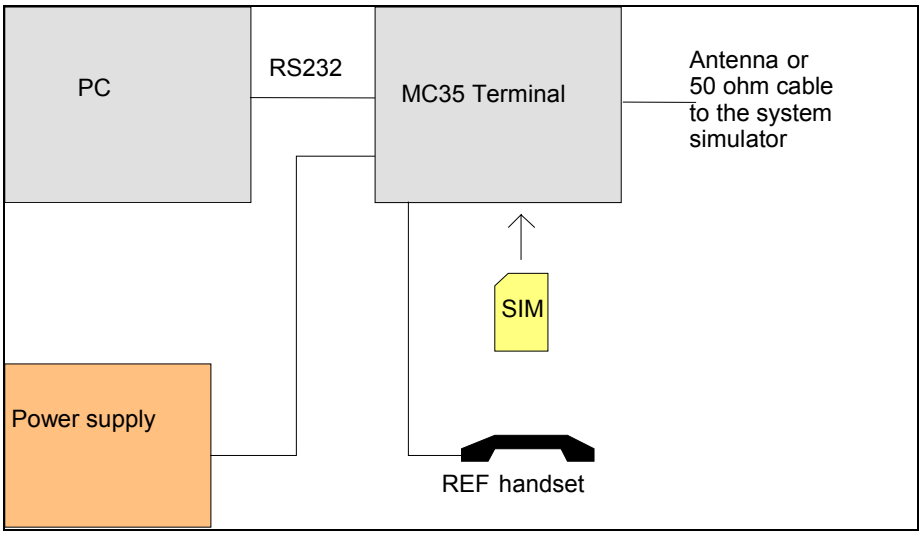


Figure 13: Reference equipment for approval

Referred to as "GSM terminal equipment" the reference configuration consists of the following components:

- MC35T with approved GSM Engine MC35
- Handsettype Votronic HH-SI-30.3V1.1/0
- PC as MMI
- Power Supply: Mains adapter Sphere Design Type FW7207/12

For ordering information please refer to [2].

For the Siemens GSM Engine MC35, an IMEI number contingent has been reserved for the basic approval of the reference configuration. It will also apply to later approvals of customer configurations incorporating the MC35 Terminal.

Approved Siemens MC35T configurations are recorded in the approval documentation.

6.1 Restrictions

Later enhancements and modifications beyond the certified configuration require extra approvals. Each supplementary approval process includes submittal of the technical documentation as well as testing of the changes made. The relevant test applications for supplementary approvals should be agreed upon with Siemens.

- No further approvals are required for customer applications that comply with the approved MC35 Terminal configuration.
- Extra approval must be obtained for applications using other accessories than those included in the approved MC35 Terminal configuration (handset, MMI implementation supported by AT commands). Information about certified configurations and accessories approved for use with the MC35 Terminal can be obtained in the appendix to EC TYPE EXAMINATION CERTIFICATE or from your local distributor.
- Applications using the "DATA ONLY" capabilities (data, SMS, fax) of the MC35 Terminal need no extra approval.

6.2 CE Conformity

The MC35 Terminal meets the requirements of the EU directives listed below and is labeled with the CE conformity mark.
- R&TTE Directive 1999/5/EG
- LVD 73/23/EEC
- EMC conformity in accordance with Directive 89/336/EEC

6.3 EMC

The MC35 Terminal meets ETS 300 342-1 requirements of equipment for vehicular and fixed use.
(Note : V_{PLUS} power fail time>1ms resets the terminal)